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ABSTRACT

A sequel to the booklet "How Games and Simulations Can Be Used in Tertiary Education," this booklet begins by looking at ways in which participative exercises of the game/simulation/case study type can be used by teachers and trainers working in further and higher education. A process for the identification of a clearly-defined need for an exercise of this type is then outlined, followed by guidelines for formulating the basic idea for a new exercise: (1) the choice of content; (2) the choice of format, e.g., a simple manual exercise, a card game, a board game, or a computer-based exercise; (3) the choice of overall structure of the exercise, e.g., a linear, branching, radial, cyclic, interactive, or composite structure; and (4) how to use these structures in each of the different types of formats. Three stages in the conversion of the basic idea into a viable educational package are also described, including deciding on the overall form of the package, producing a prototype, and field testing and revising the prototype package. Several alternative ways of making the exercise generally available are also suggested. Models of the various structures and the development process for prototype packages of each format are included, and two items recommended for further reading are listed. (MES)

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This booklet was specially written for CICED by Dr Henry Ellington of the Educational Technology Unit of Robert Gordon's Institute of Technology, Aberdeen. It contains adapted material originally published in "A Handbook of Game Design", by Henry Ellington, Eric Addinall and Fred Percival (Kogan Page, London; 1982).

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How to Design Educational Games and Simulations

Introduction

This booklet is a sequel to booklet number 8 in the series, "How games and simulations can be used in tertiary education", which it is suggested should be read *before* the present booklet.

In "How games and simulations can be used in tertiary education", we took a general look at the game/simulation/case study field and examined some of the ways in which participative exercises of this type can be used by teachers and trainers working in further and higher education. We also saw that it is not always possible to find a ready-made exercise that is capable of meeting one's particular needs, in which case the only way forward may be to have a try at designing one's own, 'custom-built' exercise. This booklet provides detailed practical guidance on how to set about such a task, showing how to identify situations where it might be appropriate to design your own exercise, how to formulate the basic idea for such an exercise, and how to convert this basic idea into a viable educational package. It also offers advice on how to make the resulting package generally available to the educational or training community if you wish to do so.

How to identify the need for a new exercise

The first stage in the process by which an exercise of the game/simulation/case study type is designed involves identification of a clearly-defined *need* for such an exercise. Let us now look at how you should set about identifying such a need.

Stage 1 : establishment of the basic design criteria for the exercise

The starting point of the design process should always be the question: "Why do you *want* to design an exercise of the game/simulation/case study type?" In the case of an exercise that is being designed for educational or training purposes, the question generally involves asking two further questions, namely:

"With what specific group(s) is the exercise to be used?"

and

"What specific educational or training objectives do you want to achieve?"

In other words, it involves establishing the *basic design criteria* of the exercise in terms of its *target population* and *design objectives*.

Stage 2 : Realisation that an exercise of the game/simulation case study type could help meet these outcomes.

Once you have established your design criteria, you should take a critical look at these and ask yourself whether an exercise of the game/simulation/case study type is likely to be the most effective way of achieving the sort of objectives you have in mind with your particular target population. In other words, what can a game, simulation or participative case study achieve that more conventional teaching or training methods cannot? (You will probably find it helpful to refer to the appropriate sections in "How games and simulations can be used in tertiary education" at this stage.) Unless there is some *distinct advantage* to be gained by using a game, simulation or case study, then there is little point in proceeding further.

Stage 3 : Study of existing exercises to see if one would meet your needs.

Assuming that the answer to the question posed in the previous stage is positive, you should then carry out a *thorough* search of the range of existing exercises in order to determine whether someone has already produced the sort of exercise that you want. As is shown in "How games and simulations can be used in tertiary education", the series of subject-based resource lists published by SAGSET-the Society for the Advancement of Games and Simulations in Education and Training - can be of great assistance here. (address: Centre for Extension Studies, University of Technology, Loughborough, Leics. LE11 3TU). If an exercise of the type you want is already available, then *use it*; there really is no point in trying to re-invent the wheel.

If a suitable exercise is not available 'off the shelf', you should again examine the full range of existing exercises in order to determine whether one of these could be adapted in order to meet your particular needs. (Guidance on how to do this is again given in "How games and simulations can be used in tertiary education".

Stage 4 : Appraisal of possible alternative strategies for achieving your objectives.

Assuming that the above process fails to identify an existing exercise that would be capable of meeting your needs, either as it stands or after suitable modification, you should again ask yourself whether the objectives that you want to achieve could be achieved by other

methods. In other words, could you achieve them equally well *without* going to all the trouble of designing a new game, simulation or case study? Only if the answer is a definite 'no' should you make the decision to go ahead with the design of such an exercise and proceed to the next stage of the design process.

How to formulate the basic idea for a new exercise

Assuming that you have worked systematically through all the above stages, and have established that a clear need for a new exercise exists, you can now move on to the first stage of the design process itself – formulating the *basic idea* for your exercise.This should be tackled in the following stages.

Stage 1 : Choosing the CONTENT of the exercise

The first step in the process is to decide (in general terms) what the *content* of the exercise should be. In many cases, this will follow more or less directly from the design criteria, particularly in the case of exercises where the desired outcomes are mainly cognitive in nature (i.e. deal with the learning, application, use or evaluation of facts or principles of some sort). Suppose, for example, that you are a chemistry teacher who wants to produce an exercise designed to help your students to understand a particular set of chemical reactions; you would almost certainly choose these reactions as the subject matter of your exercise.

In other cases, however, the choice of content may not be quite so straightforward. Indeed, the content of an exercise of the game or simulation type is often only a foundation on which a structure capable of achieving the desired design outcomes may be built. This is particularly so in the case of exercises where the main object is to help the participants to develop broad-based skills of one form or another (e.g. decision-making, interpersonal, communication or general managerial skills) or to help them to develop desirable attitudinal traits (e.g. a willingness to appreciate the points of view of other people). A designer wishing to develop an exercise for such purposes could base it on virtually any suitable subject matter relevant to the group with which it is to be used. However, exercises of this type turn out to be particularly useful if they are designed to 'kill two birds with one stone; i.e. if they use a content that is of intrinsic value and interest to the participants as a vehicle for achieving these wider, non-cognitive aims.

Stage 2 : Choosing the FORMAT of the exercise

Once a possible content for the exercise has been identified, the next step should be to choose a suitable *format*. Here, some of the main options are listed below:

- A *simple manual* exercise, i.e. an exercise that does not involve the use of special resource materials (such as packs of cards or boards) or specialised equipment (such as a computer) – only simple, easy-to-produce materials such as role cards, briefing sheets or booklets.
- A *card game*, i.e. a game that involves the use of a specially-designed pack (or packs) of cards.
- A *board game*, i.e. a game played on a specially-designed surface of some sort.
- A *computer-based* exercise, i.e. one that involves the use of an external computer (micro or mainframe) or built-in microprocessor.

In choosing the format for your exercise, your aim should be to decide which of the various possible formats would be best suited to serve as a vehicle for achieving your selected design outcomes, using the content that you have provisionally selected, and bearing in mind the production constraints of your individual situation. Obviously, your own experience and individual preference will play an important role in reaching this decision, and it is strongly recommended that you limit yourself to formats with which you will be able to work with confidence. There is little point, for example, in trying to produce a computer-based exercise if you cannot programme and do not have access to a suitable authoring system – unless, of course, you can enlist the help of a colleague who has the necessary computer skills.

In many cases, it will be found that one particular format is more suitable than any of the others for achieving the aims you have in mind. If you are trying to develop interpersonal skills, for example, you will probably find that some sort of simple manual role-playing exercise would best meet your needs. In other cases, however, more than one format may be equally suitable, and, in this event, it is probably advisable to opt for the format that will produce the simplest possible exercise capable of meeting your basic design requirements. Do not, for example, decide to produce a complex multi-strategy exercise or a sophisticated computer simulation if a simple manual game or role-playing exercise would meet your needs equally effectively.

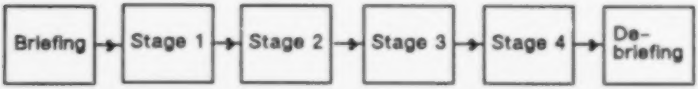
Stage 3 : Deciding on the OVERALL STRUCTURE of the exercise.

Once you have selected the format in which your exercise is to be produced, your choice of possible structures will automatically be restricted to those that can be used with that particular format. Let us therefore take a brief look at the range of structures that is possible with each of the main formats that were identified in the previous section.

Simple manual exercises

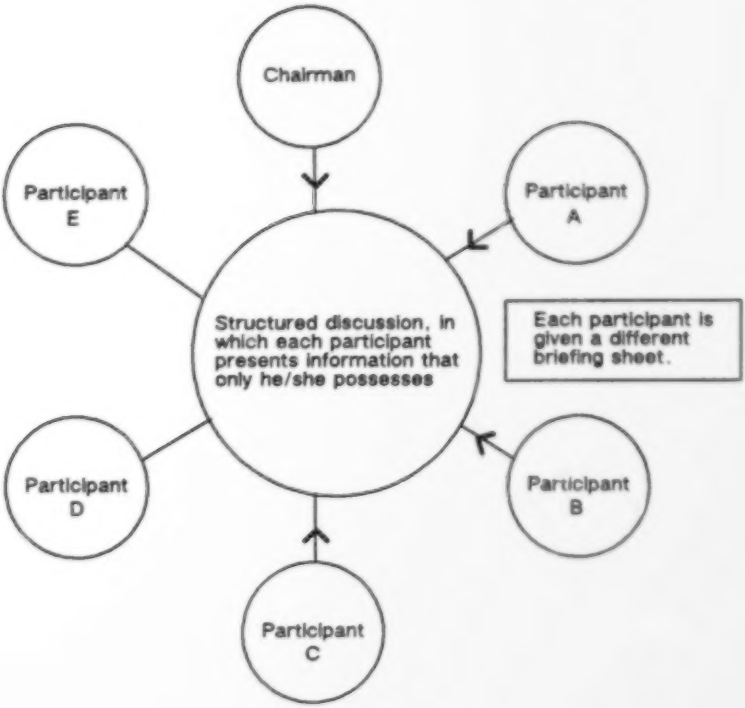
Exercises of this type can have an extremely wide range of structures. Some have a simple structure that is effectively defined by the type of basic activity that the exercise involves – e.g. solving a problem or taking part in some form of role play. In others, the structure is more complicated, constituting an overall organisational framework within which the various activities that the exercise involves take place. Most exercises of the latter type are found to fall into five basic classes:

(i) *Linear structures*, i.e. structures in which the participants work systematically through the same essentially linear programme of activities. A typical linear structure is shown below.



Such structures are extremely useful in situations where a complicated case study or procedure has to be broken down into easily-manageable stages, and are particularly suitable for developing high-level cognitive skills.

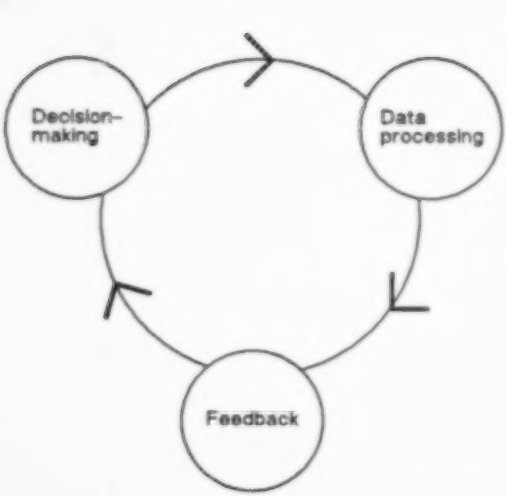
(ii) *Radial structures*, i.e. structures in which each participant (or group of participants) first carries out a set of preparatory activities specific to a given role in a scenario or point of view in a problem situation, and then presents information or argues a case at a plenary session or simulated meeting of some sort. A typical radial structure is shown below.



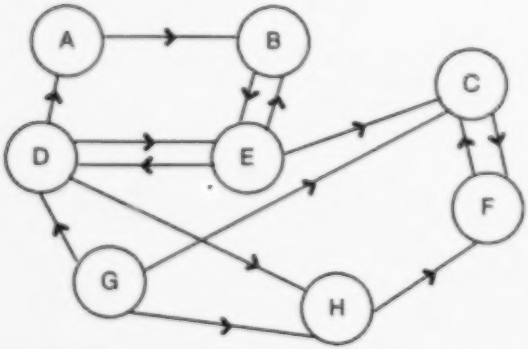
Radial structures are particularly well suited for use in complex role-playing situations such as simulated meetings, public inquiries, etc. They are ideal for developing communication and interpersonal skills, and for achieving affective objectives.

(iii) *Cyclic structures*, i.e. structures in which the activities take place in a repetitive series of cycles, as in the example shown below, which consists of a series of decision-making→data-processing →feedback cycles.

Such structures are widely used in business games and computer simulations.

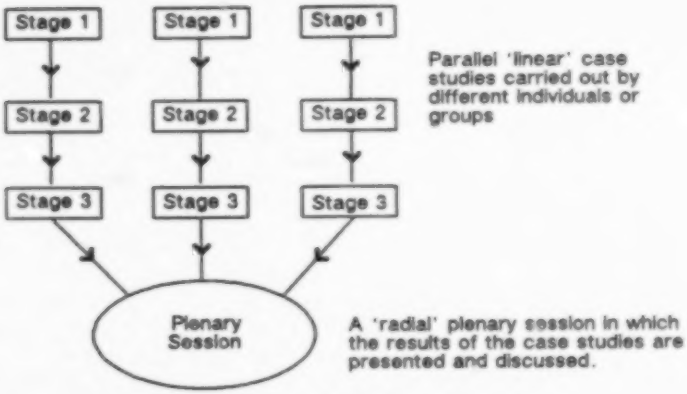


(iv) *Interactive structures*, in which the most important organisational feature is some form of multi-way interaction between individuals or groups. The interaction can take a variety of forms (e.g. exchange of information, trading, negotiation, lobbying) and can be organised in a large number of ways, but almost invariably makes the resulting exercise 'looser', less formal and less predictable than tightly-structured exercises of the linear, radial or cyclic type. A typical interactive structure is shown below.



Such structures are ideal for simulating complex social, organisational, political and international situations, and for the investigation of group dynamics. They are also useful for developing communication and interpersonal skills and for achieving affective objectives.

(v) *Composite structures*, i.e. complex structures that incorporate two or more of the 'simple' structures described above. A typical example is shown below.



By combining different 'simple' structural elements in this way, highly complex exercises can be produced. Such structures are most suitable for use in multi-strategy exercises, i.e. exercises that are designed to achieve a whole spectrum of objectives using a variety of techniques.

Card games

Here, at least four basic types of structure can be used.

(i) The *'bridge, whist'* class of structures, in which each participant is dealt a hand of cards and then has to play these individually in order to win tricks.

(ii) The *'pontoon, poker, rummy'* class of structures, in which the participants have to build up winning patterns or sequences using the cards they have been dealt and acquire during play.

(iii) The *'happy families, snap'* class of structures, in which the participants have to collect as many cards as possible from their opponents, or from a common pool.

(iv) The *'patience, solitaire'* class of structures, in which a single player has to arrange a pack (or set) of cards into a pattern of some sort.

Board games

Here, there are again at least four basic types of structure than can be used.

(i) The *'scrabble, go'* class of structures, in which the board serves as a two-dimensional matrix on which static patterns or structures can be built up.

(ii) The *'monopoly, ludo, snakes and ladders'* class of structures, in which the board is used to provide a pre-determined linear path (or pattern of paths) along or around which players have to progress.

(iii) The *'chess'* class of structures, in which the board serves as a field for mobile, two-dimensional play.

(iv) *Composite* structures, which combine two or more of the above basic structures – e.g. using movement round a Monopoly-type perimeter circuit to control pattern building or two-dimensional activities in the interior.

Computer-based exercises

Here, a vast range of different structures can be used, four of the basic ones being listed below.

(i) *Linear structures*, similar to those described for simple manual exercises.

(ii) *Branching structures*, where the path that a participant takes through the exercise is determined by decisions made or performance of tasks, as in a branching programme in programmed learning.

(iii) *Cyclic structures*, similar to those described for simple manual exercises.

(iv) *Two-dimensional* structures, in which the field of a VDU screen is used for two-dimensional pattern building, two-dimensional play, etc.

When choosing a structure for an exercise, you are strongly advised to explore the possibilities of using one of the 'standard' structures appropriate to the format in which you will be working before trying to think up a completely new structure all by yourself. You will probably find that one of these is suitable for your purposes, thus saving you a great deal of time and effort.

How to convert your basic idea into a viable educational package

Once you have developed what you think is a sound basic idea for a new exercise of the game/simulation/case study type, the next task that confronts you is the conversion of this basic idea into a viable package of materials that can be used for the purpose you have in mind. This should again be tackled in a number of separate stages:

Stage 1 : Deciding on the OVERALL FORM of the package

The first stage in the conversion process is to decide what the *overall form* of the package should be. Whatever the type of exercise that is to be produced, the package will include the following basic components:

- any specialised materials that the participants will need in order to take part in the exercise;
- a set of instructions on how to run or take part in the exercise, e.g. in the form of an organiser's guide or participants' manual.

The detailed form of the package will obviously depend on the format and overall structure that have been selected for the exercise. Typically, they will be along the following lines.

Simple manual exercises

- An organiser's guide of some sort (if appropriate).
- A user's guide of some sort, e.g. as a set of rules or manual (if appropriate).
- Any introductory material thought appropriate (e.g. an introductory sheet or booklet).
- Any resource materials needed by the participants (role sheets, briefing sheets, etc.).

Card games

- An organiser's guide of some sort (if appropriate).
- A user's guide of some sort, e.g. as a set or rules or game manual.
- A pack (or set of packs) of appropriate cards.

Board games

- An organiser's guide of some sort (if appropriate).
- A user's guide of some sort, e.g. as a set of rules or game manual.

- A suitably-designed board.
- Any ancillary materials needed to play the game (playing pieces, tokens, sets of cards, sets of money, dice, etc.).

Computer-based exercises

- An organiser's guide of some sort (if appropriate).
- A user's guide of some sort (if needed).
- The computer program(s) needed to run the exercise.
- Any ancillary materials needed (e.g. worksheets).

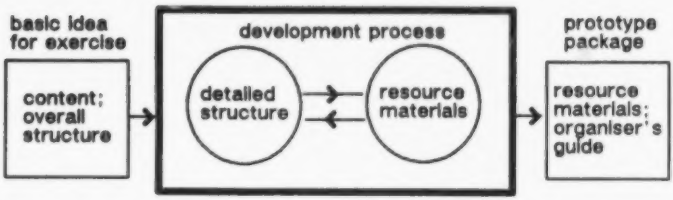
Stage 2 : Producing a prototype package

The next stage in the development of a viable educational package is the design and production of all the various materials that will be needed. Here, the best advice that can be offered to would-be designers is this: try to find an existing exercise that has a similar format and structure to that which you are wanting to produce and then base your own materials on these. (Remember Tom Lehrer's immortal advice to those wishing to achieve success in mathematics: "plagiarise!")

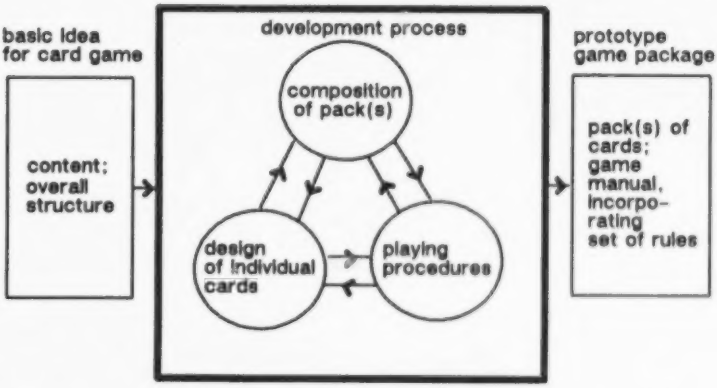
When developing the resource materials for a game, simulation or case study, it is important to make sure that each item:

- is capable of fulfilling its own specific function;
- fits into the general context of the exercise;
- is consistent with all the other materials in the package.

This will almost certainly involve a certain amount of 'tuning', i.e. revising or amending particular items as the work progresses in order to produce a self-consistent, balanced package. This stage of the development process can be thought of as a 'black box' into which you feed the basic idea for the exercise and out of which eventually emerges a prototype educational package. Just what goes on inside the black box will depend on a wide range of factors – the type of exercise being produced, the composition of the design team, the individual working styles of its members, and so on. A greatly simplified schematic representation of the process for each of the four basic classes of exercise being considered – simple manual exercises, card games, board games and computer-based exercises – is given below. These diagrams identify the main elements that must be considered in each case.

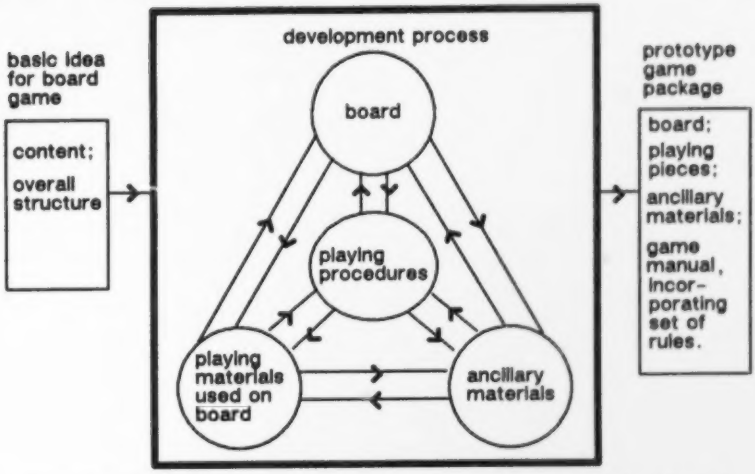


How the prototype package for a simple manual exercise is developed

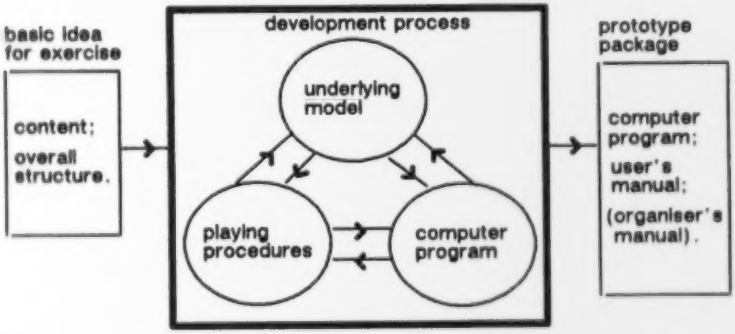


How the prototype game package for a card game is developed

Whatever the format and structure of the exercise, your primary aim should always be to produce a package of materials that can be used not only by yourself but also by any other person who wishes to use the exercise. For this reason it is essential to include in the user's manual and (if one is included) the organiser's guide *all* the information needed to take part in or use the exercise effectively. Never be afraid to spell out in detail what might (to you) appear to be obvious; it might not be quite so obvious to someone who has never seen the exercise before. Try to anticipate possible problems and show how these can be avoided or overcome.



How the prototype game package for a board game is developed



How the prototype package for a computer-based exercise is developed

Stage 3 : Field testing and revising the package

The third step in the development of a viable educational package is the process by which it is field tested in order to determine whether it is

(a) logistically and operationally sound, and

(b) capable of achieving its design objectives,

and is then revised or amended in the light of the feedback obtained.

The first full-scale field test of a package (as opposed to 'dry runs' carried out by the design team during the development of the package materials) is an extremely important stage in the development process. It should be organised and supervised by the design team, and, if possible, should be run with a group of people drawn from (or similar to) the target population. Such a field trial can have a number of possible outcomes:

(i) The exercise turns out to be a complete disaster, either from an organisational or logistical point of view or (equally important) from the point of view of its design objectives. This indicates that the design team have obviously not got things right, and that the whole concept should be critically re-examined and the exercise either abandoned or drastically modified.

(ii) The exercise proves successful in some respects but less so in others, revealing a number of basic (but not disastrous) flaws in the design. Surprising as it may seem, this is an extremely satisfactory outcome from the designer's point of view since it:

- shows that the basic idea appears to be sound;
- identifies those areas where some modification is required;
- (hopefully) gives some clues as to what these modifications should be.

Needless to say, all such changes, whether relating to the overall form of the package, the detailed contents of the resource materials, or to the method of play or organisational procedure, should be made before any further field tests are attempted.

(iii) The exercise proves to be completely successful in all respects, apart from comparatively minor points of detail which can be remedied without a major re-write. This is even more satisfactory (albeit unlikely!) and indicates that the exercise can be safely handed over to colleagues for further, more rigorous field testing. Any weaknesses identified by these further tests should obviously also be remedied.

How to make an exercise generally available

Let us assume that you have satisfactorily completed all the above stages of the design process, and have finally produced an exercise that appears to meet all its design criteria. You may well now be content to 'call it a day', and simply use the exercise for whatever purpose it was designed. You may, on the other hand, want to take the development process one stage further, and make your exercise

generally available to the educational or training community. All too often, a very promising new exercise that could be of real use to teachers or trainers throughout the country never achieves its full potential because the designer fails to take this final step.

There are three ways in which you can make a new exercise generally available:

(a) by developing a suitable 'do-it-yourself' kit for producing the package;

(b) by producing and distributing full sets of the package yourself;

(c) by having the package produced and distributed by an appropriate body.

Let us now examine each of these in greater detail.

Producing a 'do-it-yourself' kit

This is perhaps the simplest and cheapest way of making an exercise more generally available. The contents of the kit will depend very much on the format of the exercise and the nature of the materials that compose the package, but should always include the following:

- detailed instructions on how to produce *all* the materials needed to use or run the exercise, including, where appropriate, photocopy masters of any documents required by the participants;
- a copy of the user's manual and/or organiser's guide.

In the case of card or board games, where it is generally extremely time-consuming to produce multiple sets and can be difficult to find an external publisher willing to take on the exercise, production of a 'do-it-yourself' kit of this type is often the best way to publish the exercise. If you do decide to publish in this way, remember to include a statement giving users copyright clearance to make multiple copies of any relevant documents, otherwise they may be breaking the law by so doing.

Producing multiple sets of a package

In the case of simple manual exercises, where all the resource materials can be run off on a photocopier, this can again be an extremely cost-effective way of making an exercise generally available. All you need is a clean set of photocopy masters of all the various documents that are included in the package, and, of course, access to a good, fast photocopier capable of handling a large throughput. Sets of the package can then be run off in whatever numbers are required, and (if appropriate) sold at a price sufficient to cover the cost of production, postage and overheads - plus any

profit margin that you want to build in. Many highly successful educational and training exercises have been published in this way.

Publication by an appropriate body

If a suitable publisher can be found, this is by far the most satisfactory method of making an exercise generally available, since it relieves the designer of all the problems associated with mass production and distribution. It also generally results in a much-higher-quality final product.

In the case of educational packages of the game/simulation/case study type, possible publishers include:

- your own College or local Education Authority, who may well be prepared to publish a worthwhile exercise, e.g. through their central resources centre or curriculum development centre;
- the appropriate national curriculum development centre, which again may be prepared to take a worthwhile exercise on board;
- an appropriate professional body or official organisation such as the Association for Science Education and its equivalents in other subject areas.
- a commercial publishing house that already publishes packages of a similar type (e.g. Heinemann or Longman).

If you want to make any money out of the publication of your exercise, a commercial publisher is obviously your best bet – if you can persuade one to take your exercise on board.

Further Reading

1. *A Handbook of Game Design*, by H. I. Ellington, E. Addinall and F. Percival; Kogan Page, London; 1982. (A practical guide to the design process that covers all the areas dealt with in this booklet in much greater detail.)
2. *Case Studies in Game Design*, by H. I. Ellington, E. Addinall and F Percival; Kogan Page, London; 1984. (The sequel to "A Handbook of Game Design", providing detailed insight into the process by which 12 specific exercises of the game/simulation/participative case study type were developed by the authors and their colleagues.)